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Abstract
Urban flooding introduces significant risk to society. Extreme flood events can grow into national threats if timely adaptation and protection measures are not implemented. More information is needed to understand climate change impacts and other non-stationary conditions for development of suitable adaptation strategies at a regional scale.

Infrastructures are important assets in urban environments and their continuous operation is crucial to society. Urban infrastructures have a long technical lifetime. For example the technical lifetime for drainage systems is often assumed to be 100 years. On these time scales the effects of climate change will be statistically evident; because of this, adaptation of long-lived infrastructures should be investigated well ahead of their construction.

Decision-makers need to agree on how to adapt urban areas to flooding. However, non-stationarity leads to increased uncertainty and this is shown to be difficult to include into actual decision-making. Transparent methods are needed to facilitate the decision-making process. While decision-makers can gain an understanding of future climatic changes through scenarios and projections there is still a considerable knowledge gap between different projections and actual decision-making based on these projections. The large uncertainties introduced by future projections can lead to aversion in making a decision and investing in adaptation to floods.

The primary objective of this study was to develop a risk assessment and decision support framework for pluvial urban flood risk under non-stationary conditions using an Influence diagram (ID). Non-stationarity is considered to be the influence of climate change where extreme precipitation patterns change over time. The overall risk is quantified in monetary terms expressed as expected annual damage (EAD). The network is dynamic inasmuch as it assesses risk at different points in time to evaluate the non-stationarity in the urban system. The framework provides a means for decision-makers to assess how different decisions on flood adaptation affect the risk now and in the future. For the development of the ID we used the HUGIN software. The result from the ID was extended with a cost-benefit analysis defining the net benefits for the investment plans. We tested our framework in a case study where the risk for flooding was assessed on a railway track in Risskov (Aarhus). Drainage system improvements are planned for the area and our case study presents how the developed BN illustrates the increase in risk over time and the decrease in risk due to the planned improvement.

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